Express Mail No. EL816677290US

PATENT
Atty. Docket No. MIT-051CN2
(5473/53)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

PRIORITY APPLICATION Serial No. 09/324,137

APPLICANTS: Zilles et al.

SERIAL NO.: Not yet assigned

FILED: HEREWITH

TITLE: METHOD AND APPARATUS FOR DETERMINING FORCES TO BE APPLIED TO A USER THROUGH A HAPTIC INTERFACE

Assistant Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir:

This Amendment is directed to the accompanying 37 C.F.R. 1.53(b) patent application, filed as a continuation of U.S.S.N. 09/324,137 on even date herewith. After granting the application filing date and **before calculation of the fee**, kindly amend the application as follows:

IN THE SPECIFICATION:

On page 1, line 1, before "Field of the Invention" insert:

--Cross Reference to Related Application

This application is a continuation of co-pending U.S.S.N. 09/324,137, filed June 2, 1999, which is a continuation of U.S.S.N. 08/627,432, filed April 4, 1996, now U.S. Patent No. 6,111,577, issued August 29, 2000, to Zilles et al., the entire disclosure of each of which is hereby incorporated by reference.

Statement Regarding Federally Sponsored Research

This invention was made with government support under Contract Number N61339-94-C-0087 awarded by the Department of the Navy. The U.S. government may have certain rights in the invention.--

IN THE CLAIMS

Please cancel claims 1-38 without prejudice.

Please add the following new claims:

39. (New) A method for determining forces to be applied to a user through a haptic interface, the method comprising the steps of:

determining a haptic interface location in response to a position of a user;

determining a fiducial object location; and

calculating a force to be applied to the user in response to said haptic interface location and said fiducial object location.

40. (New) The method of claim 39, wherein the haptic interface is represented by a single point and the fiducial object is represented by a single point.

41. (New) The method of claim 39, wherein the fiducial object is represented as a three dimensional object.

42. (New) The method of claim 41, wherein said three dimensional object is approximated by a series of points.

43. (New) The method of claim 39, wherein said fiducial object is represented as a three dimensional object, said three dimensional object is approximated by a series of points, and the haptic interface location is a single point.

44. (New) The method of claim 39, wherein the step of determining the fiducial object location comprises the steps of:

generating a representation of a virtual object within a computer; and

computing the fiducial object location, such that the distance between the fiducial object location and the haptic interface location is minimized while maintaining that the fiducial object not pass through the virtual object.

45. (New) The method of claim 44, wherein the geometric representation of the virtual object is generated from a standard computer graphic file format.

46. (New) The method of claim 44, further comprising the step of calculating a reaction force to send to the user, wherein said reaction force depends on a distance between the haptic interface location and the fiducial object location.

47. (New) The method of claim 46, wherein said reaction force is proportional to said distance.

48. (New) The method of claim 46, wherein the step of calculating the reaction force involves calculating a component of said reaction force which depends on a difference in velocity between the haptic interface location and the fiducial object location.

49. (New) The method of claim 48, wherein said component of said reaction force which depends on the difference in velocity between the haptic interface location and the fiducial object location is proportional to said difference in velocity.

50. (New) The method of claim 44, further comprising the step of displaying on a display in a location relative to the virtual object location.

51. (New) The method of claim 50, wherein said fiducial object location is different from said haptic interface location.

52. (New) The method of claim 50, wherein said fiducial object is substantially co-located with said haptic interface location.

53. (New) The method of claim 44, wherein the method is performed iteratively until a valid fiducial object location is found.

54. (New) The method of claim 53, wherein multiple surfaces of at least one virtual object are considered in calculating a valid fiducial object location.

55. (New) The method of claim 44, wherein the virtual object deforms in response to force applied to the virtual object by the user.

56. (New) The method of claim 55, wherein the applied force comprises at least one of a damping force, a stiffness force, and a friction force.

57. (New) The method of claim 55, wherein the applied force comprises at least two of a damping force, a stiffness force, and a friction force.

58. (New) The method of claim 55, wherein the applied force comprises a damping force, a stiffness force, and a friction force.

59. (New) A method for determining forces to be applied to a user through a haptic interface; the method comprising the steps of:

determining a haptic interface location in response to a position of a user;

assigning state variables to the haptic interface location, the state variables adapted to being stored; and

computing forces to be applied to the user based on previously stored state variables of the haptic interface location.

60. (New) A system for determining force to be applied to a user through a haptic interface, the system comprising:

a computation module that determines a haptic interface location in response to a position of a user;

a locating module that determines a fiducial object location; and

a force computation module that calculates a force to be applied to the user in response to the haptic interface location and the fiducial object location.

61. (New) The system of claim 60, further comprising:

a modeling module that generates a representation of a virtual object within the system; and

a simulation module that computes the fiducial object location such that distance between the fiducial object location and the haptic interface location is minimized while maintaining a condition that the fiducial object not pass through the virtual object.

62. (New) The system of claim 61, further comprising a display module that displays a representation of the fiducial object on a display in a location relative to the virtual object location.

63. (New) The system of claim 60, wherein the haptic interface is represented by a single point and the fiducial object is represented by a single point.

64. (New) The system of claim 60, wherein the fiducial object is represented as a three dimensional object.

65. (New) The system of claim 64, wherein the three dimensional object is approximated by a series of points.

66. (New) The system of claim 60, wherein the fiducial object is represented as a three dimensional object, the three dimensional object is approximated by a series of points, and the haptic interface location is a single point.

67. (New) The system of claim 60, further comprising:

a generation module that generates a representation of a virtual object within a computer; and

a displacement module that computes the fiducial object location such that distance between the fiducial object location and the haptic interface location is minimized while maintaining a condition that the fiducial object not pass through the virtual object.

68. (New) The system of claim 60, wherein a geometric representation of the virtual object is generated from a standard computer graphic file format.

69. (New) The system of claim 60, further comprising a module that calculates a reaction force to apply to the user wherein the reaction force depends on distance between the haptic interface location and the fiducial object location.

70. (New) The system of claim 69, wherein the reaction force is proportional to the distance.

71. (New) The system of claim 69, wherein the module that calculates the reaction force calculates a component of the reaction force which depends on a difference in velocity between the haptic interface location and the fiducial object location.

72. (New) The system of claim 71, wherein the component of the reaction force which depends on the difference in velocity between the haptic interface location and the fiducial object location is proportional to the difference in velocity.

73. (New) The system of claim 60, further comprising a display for displaying on the display in a location relative to the virtual object location.

74. (New) The system of claim 73, wherein the fiducial object location is different from the haptic interface location.

75. (New) The system of claim 73, wherein the fiducial object is substantially co-located with the haptic interface location.

76. (New) The system of claim 60, further comprising a controller module that causes the locating module to iterate until a valid fiducial object location is found.

77. (New) The system of claim 76, wherein the locating module considers multiple surfaces of one or more virtual objects in calculating a valid fiducial object location.

78. (New) The system of claim 60, wherein the virtual object is adapted to deform in response to force applied to the virtual object by the user.

79. (New) The system of claim 78, wherein the applied force comprises at least one of a damping force, a stiffness force, and a friction force.

80. (New) The system of claim 78, wherein the applied force comprises at least two of a damping force, a stiffness force, and a friction force.

81. (New) The system of claim 78, wherein the applied force comprises a damping force, a stiffness force, and a friction force.

REMARKS

This application is a continuation of co-pending U.S. Patent Application Serial No. 09/324,137.

The specification has been amended to recite the relation of the present application to prior applications and to acknowledge that the invention was made with government support under Contract Number N61339-94-C-0087 awarded by the Department of the Navy.

Claims 1-38 have been cancelled without prejudice. New claims 39-81 have been added. Support for the new claims may be found throughout the Specification and Drawings, and in particular at least at the locations indicated in the following Table I. No new matter has been added. A separate listing of the claims pending after cancellation, without prejudice, of originally filed claims 1-38 and addition of new claims 39-81 is provided herewith in accordance with 37 CFR 1.121(c)(1)(i).

Table I

Claim	Location of support in application
39	page 8, lines 1 - 3, page 9, lines 1 - 24, page 10, lines 1 - 6, Figure 2
40	page 13, lines 5 - 23, Figure 4A - 4C
41	page 8, lines 8 - 9
42	page 8, lines 7 - 8
43	page 8, lines 7 - 9, page 13, lines 5 - 23, Figure 4A - 4C
44	page 8, lines 10 - 12, page 9, lines 14 - 22
45	page 8, lines 24 - 28, Figure 3
46	page 10, lines 1- 20, Figure 2
47	page 10, lines 1- 20, Figure 2
48	page 11, lines 4 - 13
49	page 11, lines 14 - 16
50	page 8, lines 22 - 23
51	page 7, lines 4 - 5

52	page 7, lines 2 - 4
53	page 15, lines 10 - 22
54	page 14, line 28 to page 15, line 5
55	page 13, lines 1 - 4
56	page 22, lines 13 - 16
57	page 22, lines 4 - 16
58	page 22, lines 13 - 16
59	page 9, lines 1 - 24, page 10, lines 21 - 26, page 10, lines 1 - 6, Figure 2
60	page 4, lines 3 - 10, page 8, lines 1 - 3, page 9, lines 1 - 24, page 10, lines 1 - 6, Figure 2
61	page 4, lines 3 - 10, page 8, lines 10 - 12, page 9, lines 14 - 24
62	page 4, lines 3 - 10, page 9, lines 25 - 27
63	page 4, lines 3 - 10, page 13, lines 5 - 23, Figure 4A - 4C
64	page 4, lines 3 - 10, page 8, lines 8 - 9
65	page 4, lines 3 - 10, page 8, lines 7 - 8
66	page 4, lines 3 - 10, page 8, lines 7 - 9, page 13, lines 5 - 23, Figure 4A - 4C
67	page 4, lines 3 - 10, page 8, lines 10 - 12, page 9, lines 14 - 22
68	page 4, lines 3 - 10, page 8, lines 24 - 28, Figure 3
69	page 4, lines 3 - 10, page 10, lines 1- 20, Figure 2
70	page 4, lines 3 - 10, page 10, lines 1- 20, Figure 2
71	page 4, lines 3 - 10, page 11, lines 4 - 13
72	page 4, lines 3 - 10, page 11, lines 14 - 16
73	page 4, lines 3 - 10, page 8, lines 22 - 23
74	page 4, lines 3 - 10, page 7, lines 4 - 5
75	page 4, lines 3 - 10, page 7, lines 2 - 4
76	page 4, lines 3 - 10, page 15, lines 10 - 22
77	page 4, lines 3 - 10, page 14, line 28 to page 15, line 5
78	page 4, lines 3 - 10, page 13, lines 1 - 4

79	page 4, lines 3 - 10, page 22, lines 4 - 16
80	page 4, lines 3 - 10, page 22, lines 13 - 16
81	page 4, lines 3 - 10, page 22, lines 4 - 16

If the Examiner believes that a telephone conversation would advance the prosecution of this application, the Examiner is cordially invited to telephone the undersigned attorney of record.

Respectfully submitted,

Dated: October 26, 2001

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Clean Copy of Claims as Added on October 26, 2001

39. (New) A method for determining forces to be applied to a user through a haptic interface, the method comprising the steps of:

determining a haptic interface location in response to a position of a user;

determining a fiducial object location; and

calculating a force to be applied to the user in response to said haptic interface location and said fiducial object location.

40. (New) The method of claim 39, wherein the haptic interface is represented by a single point and the fiducial object is represented by a single point.

41. (New) The method of claim 39, wherein the fiducial object is represented as a three dimensional object.

42. (New) The method of claim 41, wherein said three dimensional object is approximated by a series of points.

43. (New) The method of claim 39, wherein said fiducial object is represented as a three dimensional object, said three dimensional object is approximated by a series of points, and the haptic interface location is a single point.

44. (New) The method of claim 39, wherein the step of determining the fiducial object location comprises the steps of:

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45. (New) The method of claim 44, wherein the geometric representation of the virtual object is generated from a standard computer graphic file format.

46. (New) The method of claim 44, further comprising the step of calculating a reaction force to send to the user, wherein said reaction force depends on a distance between the haptic interface location and the fiducial object location.

47. (New) The method of claim 46, wherein said reaction force is proportional to said distance.

48. (New) The method of claim 46, wherein the step of calculating the reaction force involves calculating a component of said reaction force which depends on a difference in velocity between the haptic interface location and the fiducial object location.

49. (New) The method of claim 48, wherein said component of said reaction force which depends on the difference in velocity between the haptic interface location and the fiducial object location is proportional to said difference in velocity.

50. (New) The method of claim 44, further comprising the step of displaying on a display in a location relative to the virtual object location.

51. (New) The method of claim 50, wherein said fiducial object location is different from said haptic interface location.

52. (New) The method of claim 50, wherein said fiducial object is substantially co-located with said haptic interface location.

53. (New) The method of claim 44, wherein the method is performed iteratively until a valid fiducial object location is found.

54. (New) The method of claim 53, wherein multiple surfaces of at least one virtual object are considered in calculating a valid fiducial object location.

55. (New) The method of claim 44, wherein the virtual object deforms in response to force applied to the virtual object by the user.

56. (New) The method of claim 55, wherein the applied force comprises at least one of a damping force, a stiffness force, and a friction force.

57. (New) The method of claim 55, wherein the applied force comprises at least two of a damping force, a stiffness force, and a friction force.

58. (New) The method of claim 55, wherein the applied force comprises a damping force, a stiffness force, and a friction force.

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assigning state variables to the haptic interface location, the state variables adapted to being stored; and

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60. (New) A system for determining force to be applied to a user through a haptic interface, the system comprising:

a computation module that determines a haptic interface location in response to a position of a user;

a locating module that determines a fiducial object location; and

a force computation module that calculates a force to be applied to the user in response to the haptic interface location and the fiducial object location.

61. (New) The system of claim 60, further comprising:

a modeling module that generates a representation of a virtual object within the system; and

a simulation module that computes the fiducial object location such that distance between the fiducial object location and the haptic interface location is minimized while maintaining a condition that the fiducial object not pass through the virtual object.

62. (New) The system of claim 61, further comprising a display module that displays a representation of the fiducial object on a display in a location relative to the virtual object location.

63. (New) The system of claim 60, wherein the haptic interface is represented by a single point and the fiducial object is represented by a single point.

64. (New) The system of claim 60, wherein the fiducial object is represented as a three dimensional object.

65. (New) The system of claim 64, wherein the three dimensional object is approximated by a series of points.

66. (New) The system of claim 60, wherein the fiducial object is represented as a three dimensional object, the three dimensional object is approximated by a series of points, and the haptic interface location is a single point.

67. (New) The system of claim 60, further comprising:

a generation module that generates a representation of a virtual object within a computer; and

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68. (New) The system of claim 60, wherein a geometric representation of the virtual object is generated from a standard computer graphic file format.

69. (New) The system of claim 60, further comprising a module that calculates a reaction force to apply to the user wherein the reaction force depends on distance between the haptic interface location and the fiducial object location.

70. (New) The system of claim 69, wherein the reaction force is proportional to the distance.

71. (New) The system of claim 69, wherein the module that calculates the reaction force calculates a component of the reaction force which depends on a difference in velocity between the haptic interface location and the fiducial object location.

72. (New) The system of claim 71, wherein the component of the reaction force which depends on the difference in velocity between the haptic interface location and the fiducial object location is proportional to the difference in velocity.

73. (New) The system of claim 60, further comprising a display for displaying on the display in a location relative to the virtual object location.

74. (New) The system of claim 73, wherein the fiducial object location is different from the haptic interface location.

75. (New) The system of claim 73, wherein the fiducial object is substantially co-located with the haptic interface location.

76. (New) The system of claim 60, further comprising a controller module that causes the locating module to iterate until a valid fiducial object location is found.

77. (New) The system of claim 76, wherein the locating module considers multiple surfaces of one or more virtual objects in calculating a valid fiducial object location.

78. (New) The system of claim 60, wherein the virtual object is adapted to deform in response to force applied to the virtual object by the user.

79. (New) The system of claim 78, wherein the applied force comprises at least one of a damping force, a stiffness force, and a friction force.

80. (New) The system of claim 78, wherein the applied force comprises at least two of a damping force, a stiffness force, and a friction force.

81. (New) The system of claim 78, wherein the applied force comprises a damping force, a stiffness force, and a friction force.